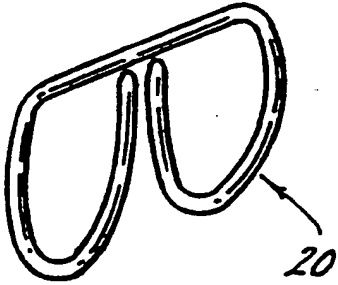




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(21) International Application Number: <b>PCT/US92/00209</b> (22) International Filing Date: <b>8 January 1992 (08.01.92)</b> (30) Priority data: <b>653,353</b> <b>6 February 1991 (06.02.91)</b> <b>US</b> (71) Applicant: <b>MINNESOTA MINING AND MANUFACTURING COMPANY [US/US]; 3 M Center, Post Office Box 33427, Saint Paul, MN 55133-3427 (US).</b> (72) Inventors: <b>VIDAL, Claude ; REDMOND, Russell, J. ; P.O. Box 33427, Saint Paul, MN 55133-3427 (US).</b> (74) Agents: <b>HOHENSHELL, Jeffrey, J. et al.; P.O. Box 33427, Saint Paul, MN 55133-3427 (US).</b>	(81) Designated States: <b>AT (European patent), BE (European patent), CA, CH (European patent), DE (European patent), DK (European patent), ES (European patent), FR (European patent), GB (European patent), GR (European patent), IT (European patent), JP, LU (European patent), MC (European patent), NL (European patent), SE (European patent).</b>  <b>Published</b> <i>With international search report.</i>	
(54) Title: <b>IMPROVED SURGICAL HARDWARE WITH BACTERIOSTATIC SILVER COATING, AND METHOD OF USING SAME</b>   <b>20</b>		
(57) Abstract  A staple, wire suture, clip, or other item of surgical hardware is disclosed which can be used to close a wound, made from a high strength metal to have a low profile design to minimize interference and disturbance of the wound, and having a bacteriostatic silver coating to reduce the risk of wound infection from the hardware. A method of closing surgical wounds with reduced risk of infection is also disclosed, the method includes the steps of closing the wound with a staple, wire suture, clip, or other item of surgical hardware made from a high strength metal that has a silver coating.		

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IMPROVED SURGICAL HARDWARE WITH  
BACTERIOSTATIC SILVER COATING, AND METHOD OF USING SAME

5     BACKGROUND OF THE INVENTION

          This invention relates to surgical hardware of the type used to close wounds, and to an improved method of closing wounds using such hardware.

10           Various items of metal hardware have been developed to assist in closing wounds. At one time such hardware was made from solid silver. However, because of silver's high ductility and relatively low strength, silver hardware had to be made very coarse to have adequate mechanical  
15           properties. For many applications solid silver hardware was objectionably coarse. High strength metals such as stainless steel and titanium, permit more slender, clinically desirable hardware designs, and have for decades been the state of the art materials for surgical hardware.

20           Wound infection is always a serious concern because of its system-wide effect and retardation of normal wound healing, but when surgical hardware is required and used there are additional potential complications from wound infection including dehiscence or splitting of the wound,  
25           leakage from the wound, and formation of adhesions. While conventional steel and titanium hardware can be sterilized, it does not appear to have significant bacteriostatic effect, and may actually promote infection compared with other materials. Nevertheless, because these high strength  
30           metals permit the manufacture of such small, high strength hardware, these metals are still widely used.

SUMMARY OF THE INVENTION

35           The present invention provides an improved item of surgical hardware that provides the strength and compact size of a high strength metal such as stainless steel or titanium, and bacteriostatic properties to reduce the risk of wound infection. This hardware allows wounds to be

neatly and effectively closed, and provides some bacteriostatic action that reduces the risk of many of the complications encountered in the use of surgical hardware.

The invention relates to a staple, wire suture, clip,  
5 or other item of surgical hardware used in closing wounds. Generally, the surgical hardware constructed according to the principles of the present invention comprises an item of surgical hardware that is made from a high strength metal, for example stainless steel or titanium, and which has a  
10 silver coating. The silver coating may be either silver plating, or a coating of silver salt. Generally the method of closing wounds according to the present invention comprises closing the wounds with surgical hardware made from a high strength metal and which has a silver coating.

15 The hardware of the present invention provides all of the advantages of being constructed from a high strength metal, including high strength and compact size, and the additional benefit of bacteriostatic action which helps to reduce the risk of complications resulting from the use of  
20 the hardware. The compact design permitted by the present invention ensures that the hardware has sufficient strength to hold the wound closed, and a sufficiently compact size that it does not unduly disturb the wound site or interfere with healing. The cost of manufacturing hardware according  
25 to the principles of the present invention is only marginally higher than the cost of manufacturing conventional hardware. The method of this invention provides a way to close wounds with reduced risk of infection and complications.

30 These and other features and advantages will be in part apparent and in part pointed out hereinafter.

#### BRIEF DESCRIPTION OF THE DRAWINGS

35 FIGURE 1 is a perspective view of an internal (soft tissue) staple constructed according to the principles of this invention;

FIGURE 2 is a perspective view of a skin staple constructed according to the principles of this invention;

FIGURE 3 is a perspective view of a fascia staple constructed according to the principles of this invention;

5       FIGURE 4 is a perspective view of a vascular staple constructed according to the principles of this invention;

FIGURE 5 is a perspective view of a vascular clip constructed according to the principles of this invention;

10       FIGURE 6 is a perspective view of a wire suture constructed according to the principles of this invention; and

FIGURE 7 is a cross-sectional view of the wire suture, taken along the plane of line 7-7 in Figure 6.

15       Corresponding reference numerals indicate corresponding parts throughout the several views of the drawings.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

20       Surgical staples constructed according to the principles of the present invention are indicated generally as 20, 22, 24, and 26 in Figures 1 - 4. A surgical clip constructed according to the principles of the present invention is indicated generally as 28 in Figure 5. A wire suture constructed according to the principles of the  
25       present invention is indicated generally as 30 in Figure 6. Although the present invention is described with respect to staples, clips, and sutures, the invention is not so limited and relates to any item of surgical hardware of the type used to close wounds.

30       The staples 20 - 26, the clip 28, and the suture 30 are made from a high strength surgical metal such as a stainless steel or titanium. Because they are constructed of a high strength material, these items have superior strength, and more importantly they can be designed to be small and  
35       compact so that they do not unnecessarily disturb the wound or interfere with proper healing. However, unlike any prior art item of surgical hardware, the staples 20 - 26, the clip 28, and the wire suture 30 have a silver coating. This is best shown in Figure 7 where the suture is shown as

The silver coating may be silver plating applied by a hot dip or electro-deposition process, or some other method. Alternatively, the coating may be a silver salt applied to the exterior of the item of hardware, for example silver nitrate, or silver-zinc allantoinate.

The bacteriostatic effect of the hardware of this invention was tested by introducing a silver coated staple according to the principles of this invention, a stainless steel staple, and titanium staple into two difference agar media: Trypticase Soy Sheep Agar and Mueller Hinton Agar. Each of the staples was screened against staph aureus, Escherichia coli, Pseudomonas aeruginosa, and strep faecales. The plates were inoculated with a standard turbidity of a 0.5 McFarland standard. The staples were placed on top of the agar and the plates were incubated at 35°C for 24 hours. As illustrated in the following table, only the silver coated staple of the present invention showed any bacteriostatic action showing a zone of inhibition around the staple.

[illegible]

In view of the above, it will be seen that the several objects of the invention are achieved and other advantageous results attained.

5       As various changes could be made in the above constructions without departing from the scope of the invention, it is intended that all matter contained in the above description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limited  
10       sense.

## WHAT IS CLAIMED IS:

1. An improved staple, wire suture, clip, or other metallic item of surgical hardware of the type made from a high strength metal such as stainless steel or titanium, the improvement comprising a silver coating on the surface of the hardware.

2. The hardware according to claim 1 wherein the silver coating comprises silver plating.

3. The hardware according to claim 1 wherein the silver coating comprises silver salts.

4. A staple, wire suture, clip, or other item of surgical hardware used to close a wound, made from a high strength metal to have a low profile design to minimize interference and disturbance of the wound, and having a bacteriostatic silver coating to reduce the risk of wound infection from the hardware.

5. The hardware according to claim 4 wherein the silver coating comprises silver plating.

6. The hardware according to claim 4 wherein the silver coating comprises silver salts.

7. A method of closing surgical wounds with reduced risk of infection comprising the step of closing the wound with a staple, wire suture, clip or other item of surgical hardware made from a high strength metal that has a silver coating.

8. The method according to claim 4 wherein the silver coating comprises silver plating.

9. The method according to claim 4 wherein the silver coating comprises silver salts.



10. A surgical staple having bacteriostatic coating.

11. A surgical staple according to claim 1 wherein said bacteriostatic coating is silver.

FIG. 1.

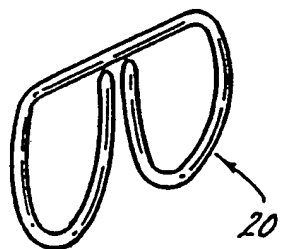


FIG. 2.

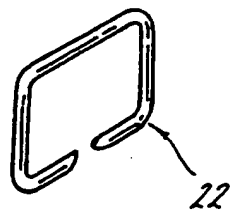


FIG. 3.

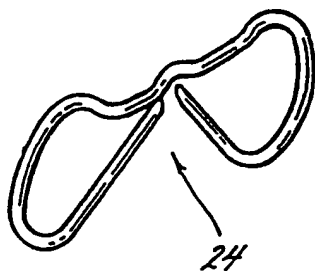


FIG. 4.

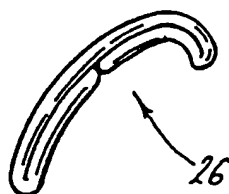


FIG. 7.

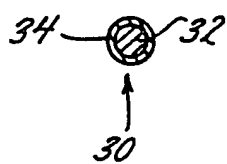


FIG. 5.

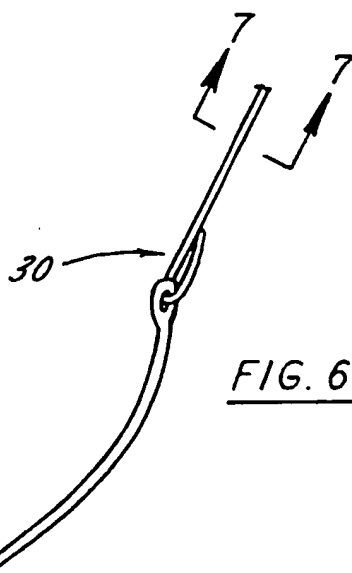
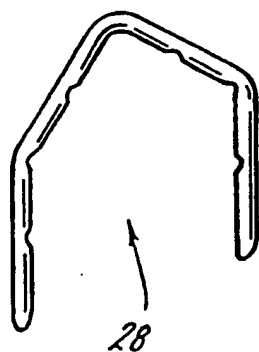
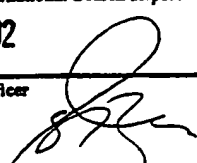


FIG. 6.

## INTERNATIONAL SEARCH REPORT

PCT/US 92/00209

International Application No

<b>I. CLASSIFICATION OF SUBJECT MATTER</b> (If several classification symbols apply, indicate all) <sup>6</sup>		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. 5 A61B17/064		
<b>II. FIELDS SEARCHED</b>		
Minimum Documentation Searched <sup>7</sup>		
Classification System	Classification Symbols	
Int.Cl. 5	A61B	
Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched <sup>8</sup>		
<b>III. DOCUMENTS CONSIDERED TO BE RELEVANT<sup>9</sup></b>		
Category <sup>10</sup>	Citation of Document, <sup>11</sup> with indication, where appropriate, of the relevant passages <sup>12</sup>	Relevant to Claim No. <sup>13</sup>
X	EP,A,0 206 024 (BECTON) 30 December 1986 see claims 1,4,11,12,14 ---	1-11
A	EP,A,0 255 248 (MINNESOTA) 3 February 1988 see abstract ---	3,6,9
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<b>IV. CERTIFICATION</b>		
Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report	
27 APRIL 1992	6. 05. 92	
International Searching Authority	Signature of Authorized Officer	
EUROPEAN PATENT OFFICE	BARTON S. 	

**ANNEX TO THE INTERNATIONAL SEARCH REPORT  
ON INTERNATIONAL PATENT APPLICATION NO. US 9200209  
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This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on  
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